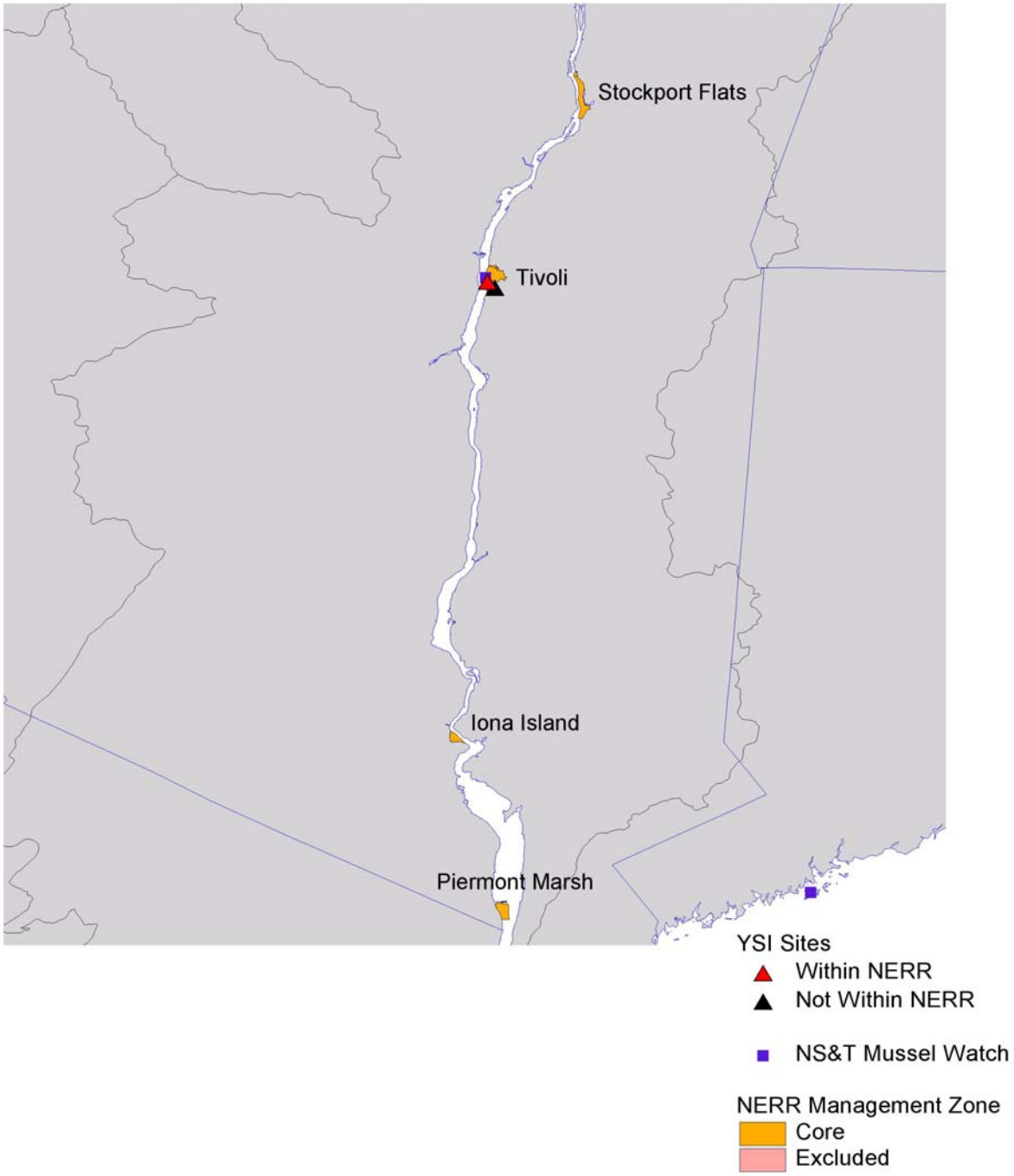
Hudson River



Hudson River, Sawkill Creek (HUDSK)

Characterization (Latitude = 42°01'54" N; Longitude = 73°53'59" W)
Sawkill Creek drains a watershed of 69 km^2. Water depth ranges between 1.5 and 4.5 m depending on creek water levels and the width is about 7 m. Creek bottom habitats are predominantly sand, gravel, and glacial till without bottom vegetation. Sawkill Creek is a shady creek surrounded by a mixed hardwood forest of maple, oak, hemlock, and pine. Upland land use near the sampling site includes forests, agriculture, and low- to medium-density residential housing. Activities that potentially impact the site include residential runoff from lawn fertilizers and septic tanks.

Descriptive Statistics
Thirty-three deployments were made at this site between Apr-Jul 1996 and Apr-Dec 1997 and 1998 (Figure 50). Mean deployment duration was 17.7 days. Only two deployments (Jul, Nov 1997) were less than 10 days.

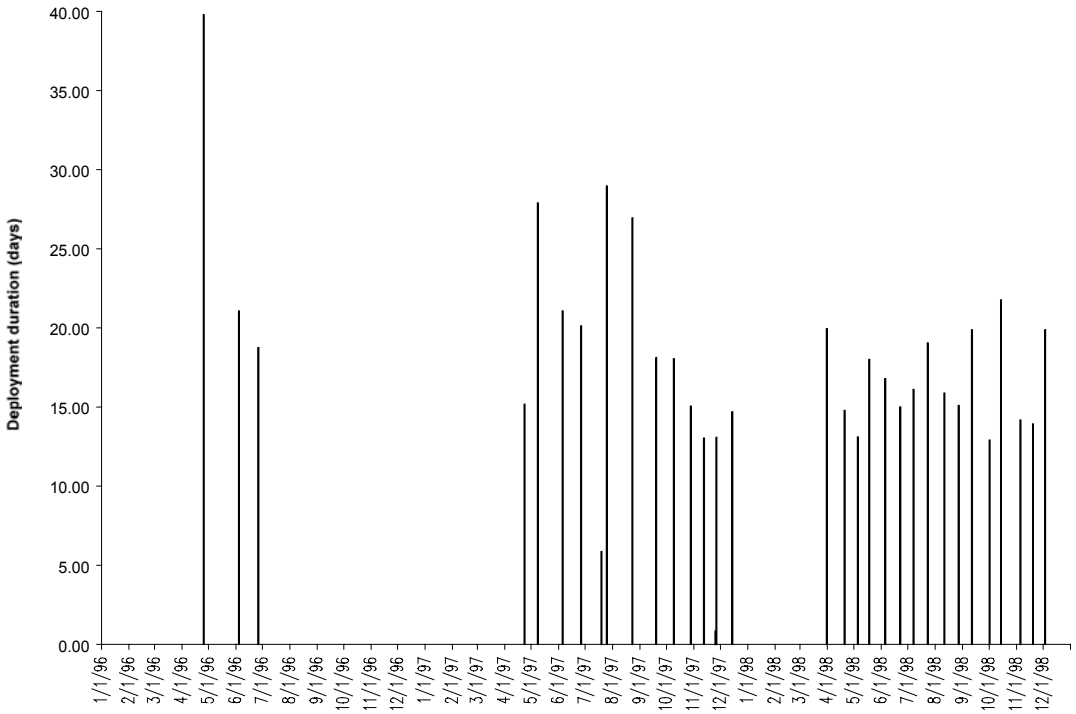


Figure 50. Hudson River, Sawkill Creek deployments (1996-1998).

Fifty-two percent of annual depth data were included in analyses (17% in 1996, 65% in 1997, and 73% in 1998). Sensors, located on the upstream side of a dam spillway, were typically deployed at a depth of 0.7 m below the water surface and 0.5 m above the bottom sediment. Minor fluctuations (≤ 0.4 m) in daily and bi-weekly water depth were evident from scatter plots. Harmonic regression analysis attributed 50% of depth variance to 24 hour cycles, 45% of depth variance to interaction between 12.42 hour and 24 hour cycles, and 5% of depth variance to 12.42 hour cycles.

Forty-nine percent of annual water temperature data were included in analyses (17% in 1996, 58% in 1997, and 73% in 1998). Water temperature followed a seasonal cycle; however, because no data were collected in Jan-Feb, true annual minimum temperature may not be known (Figure 51). Mean water temperature was 12-14°C in Apr-May, 20-21°C in Jul-Aug, and 3-5°C in Nov-Dec. Minimum and maximum water temperatures between 1996-1998 were 0.1°C (Dec 1997) and 24.3°C (Jul 1997), respectively. Scatter plots suggest moderate fluctuations (1-2°C) in daily water temperature and strong fluctuations (≥5°C) in bi-weekly water temperature. Harmonic regression analysis attributed 85% of temperature variance to 24 hour cycles, 14% of temperature variance to interaction between 12.42 hour and 24 hour cycles, and 1% of temperature variance to 12.42 hour cycles.

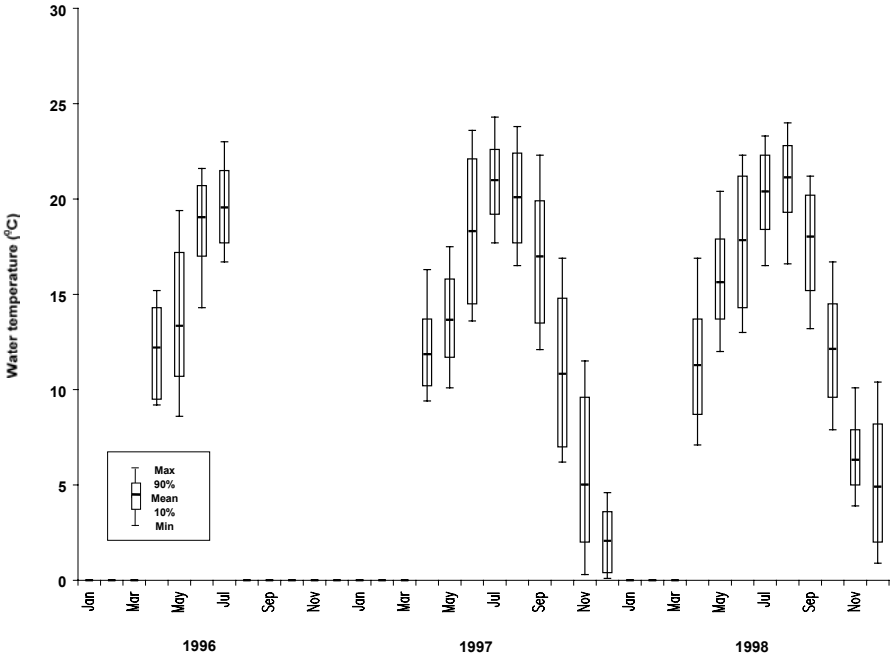


Figure 51. Water temperature statistics for Sawkill Creek, 1996-1998.

Forty-one percent of annual salinity data were included in analyses (17% in 1996, 32% in 1997, and 73% in 1998). All salinity measurements were between 0.1 and 0.2 ppt, with no discernable seasonal pattern. Harmonic regression analysis attributed 73% of salinity variance to interaction between 12.42 hour and 24 hour cycles, 22% of salinity variance to 24 hour cycles, and 5% of salinity variance to 12.42 hour cycles.

Forty-three percent of annual dissolved oxygen (% saturation) data were included in analyses (17% in 1996, 38% in 1997, and 73% in 1998). Mean percent saturation varied from 80-100% throughout the data set. Minimum and maximum DO between 1996-1998 was 18.9% saturation and 122.1% saturation, respectively. Hypoxia and supersaturation were never observed. Scatter plots indicated minor fluctuations (≤20%) in daily and bi-weekly percent saturation throughout the data set, except for Jul 1998 when fluctuations approached 80%. Harmonic regression analysis attributed 83% of DO variance to 24 hour cycles, 15% of DO variance to interaction between 12.42 hour and 24 hour cycles, and 2% of DO variance to 12.42 hour cycles.

Photosynthesis/Respiration

Less than one third (31%) of the data used to calculate metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor). This reduced data set (when flow in the creek was less than 0.4 m3/s) was used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 17). Because the YSI is deployed just upstream of a dam in the creek, physical processes such as advection of different water masses and enhanced exchange across the air-water interface probably control the oxygen dynamics rather than biological processes. Instrument drift during the duration of the deployments was not a significant problem at this site. Total respiration only slightly exceeded gross production at Sawkill Creek; thus, the net ecosystem metabolism and P/R ratio indicated that this is a site where production and respiration are balanced (Figure 52). Temperature was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Respiration increased as temperature increased, while gross production decreased as temperature increased. Net ecosystem metabolism became more heterotrophic as temperature increased. In this freshwater system, salinity was always zero ppt.

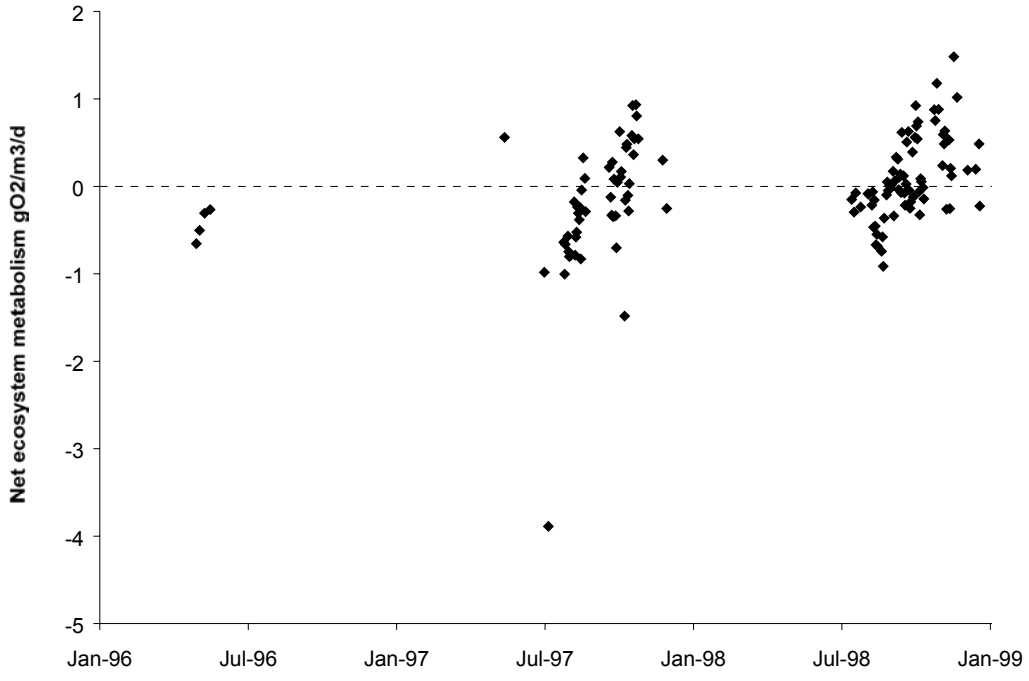


Figure 52. Net metabolism at Sawkill Creek, 1996-1998.

Table 17. Summary of metabolism data and statistics at Sawkill Creek, 1996-1998.

Sawkill Creek	mean	s.e.
Water depth (m)	1.0	
Net production $gO_2/m3/d$	0.30	0.04
Gross production $gO_2/m3/d$	0.65	0.04
Total respiration $gO_2/m3/d$	0.69	0.06
Net ecosystem metabolism g $O_2/m3/d$	-0.03	0.05
Net ecosystem metabolism g C/m2/y	18	
P/R	0.95	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	31 %	
Paired t-test on gross production and total respiration	ns	
Correlation coefficient	Temperature	Salinity
Gross production	-0.34	ns
Total respiration	0.19	ns
Net ecosystem metabolism	-0.51	ns

Hudson River, Tivoli South Bay (HUDTS)

Characterization (Latitude = 42°02'15"N; Longitude = 73°55'10"W)
Tidal range at Tivoli South Bay is 1.19 m. The bay is 1.3 km long (mainstream linear dimension), has an average depth of 1 m MHW, and an average width of 530 m. A railroad embankment (consisting of three bridges) along the western edge of Tivoli South Bay separates this bay from the Hudson River, although there is a nearly complete tidal exchange between Hudson Bay and Tivoli South Bay. The sampling site is located at one of the railroad bridges where the depth is 1 m MHW. Creek bottom habitats are predominantly silt-sand, with extensive beds of *Trapa natans* (Eurasian water chestnut, exotic) in Tivoli South Bay and extensive beds of *Vallisneria americana* (Water celery, native) in the shallows of the Hudson River adjacent to Tivoli South Bay. At low tide, much of the bay is exposed mudflat with water chestnut. The dominant marsh vegetation near the sampling site is cattail. Upland vegetation is primarily mixed hardwood forest. Upland land use near the sampling site includes forests, agriculture, and low to medium density residential housing. Activities that potentially impact the site include septic tanks and lawn fertilizers.

Descriptive Statistics
Thirty-seven deployments were made at this site between Apr-Dec in 1996 and 1998 and May-Dec in 1997 (Figure 53). Mean deployment duration was 18.8 days. Only three deployments, all in Dec 1997, were less than 10 days.

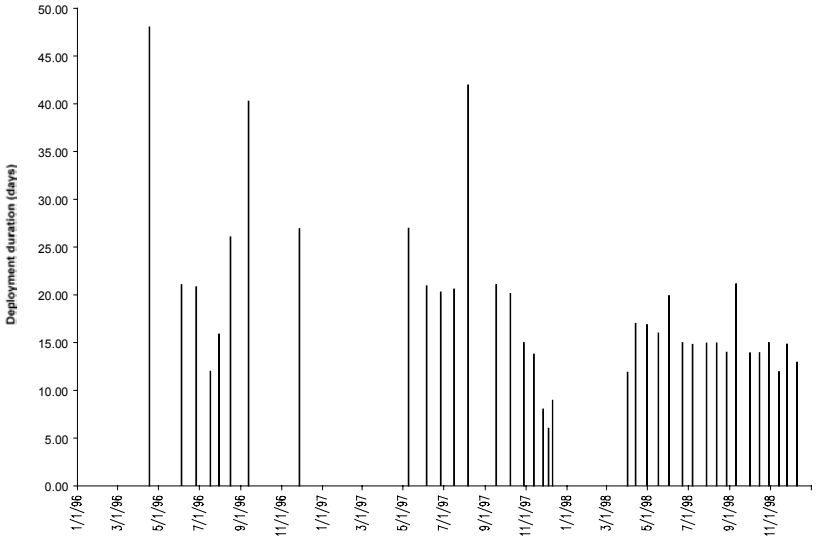


Figure 53. Hudson River, Tivoli South Bay deployments (1996-1998).

Fifty-seven percent of annual depth data were included in analyses (47% in 1996, 54% in 1997, and 70% in 1998). Sensors were typically deployed at a depth of 0.9 m below the water surface and 0.5 m above the bottom sediment. Strong fluctuations (1-2 m) in water depth were evident from scatter plots for daily and bi-weekly intervals, with consistent amplitude throughout the data set. Harmonic regression analysis attributed 91% of depth variance to 12.42 hour cycles, 5% of depth variance to 24 hour cycles, and 4% of depth variance to interaction between 12.42 hour and 24 hour cycles.

Fifty-five percent of annual water temperature data were included in analyses (47% in 1996, 48% in 1997, and 70% in 1998). Water temperature followed a seasonal cycle; however, because data were not collected in Jan-Mar, annual minimum water temperature may not be known (Figure 54). Mean water temperature was typically 10-14°C in Apr-May, 24-25°C in Jul-Aug, and 4-6°C in Nov-Dec. Minimum and maximum water temperatures between 1996-1998 were 0°C (Dec 1996, 1997) and 29.8°C (Jul 1997), respectively. Scatter plots suggest strong fluctuation (2-5°C) in daily water temperature and even stronger fluctuation (5-10°C) in bi-weekly water temperatures. Harmonic regression analysis attributed 42% of temperature variance to 24 hour cycles, 25% of variance to 12.42 hour cycles, and 33% of variance to interaction between 12.42 hour and 24 hour cycles.

Forty-four percent of annual salinity data were included in analyses (27% in 1996, 35% in 1997, and 70% in 1998). All salinity measurements were between 0 and 0.1 ppt, with no discernable seasonal pattern. Harmonic regression analysis attributed 36% of salinity variance to 12.42 hour cycles, 35% of salinity variance to interaction between 12.42 hour and 24 hour cycles, and 29% of salinity variance to 24 hour cycles.

Forty-four percent of annual dissolved oxygen (% saturation) data were included in analyses (47% in 1996, 27% in 1997, and 59% in 1998). Mean DO followed a seasonal cycle, with lowest percent saturation recorded in Jul-Sep (70-85% sat) and greatest percent saturation recorded in spring and fall (85-100%). Minimum and maximum percent saturation between 1996-1998 was 8.3% (Aug 1998) and 154% (Jun 1996), respectively. Hypoxia was observed in two months (Jul-Aug 1998) and, when

present, hypoxia persisted for <1.5% of the first 48 hours post-deployment on average (Figure 55). Super-saturation was observed in four months (Apr, Jun 1996; Jul 1997; Jun 1998) and, when present, supersaturation persisted for <7% of the first 48 hours post-deployment on average. Scatter plots suggest moderate fluctuation (20-60%) in percent saturation over daily and bi-weekly cycles, but strong fluctuations (60-100%) were observed in Jun 1996, Jul 1997, and Jun-Sep 1998. Harmonic regression analysis attributed 59% of DO variance to 12.42 hour cycles, 19% of DO variance to interaction between 12.42 hour and 24 hour cycles, and 22% of DO variance to 24 hour cycles.

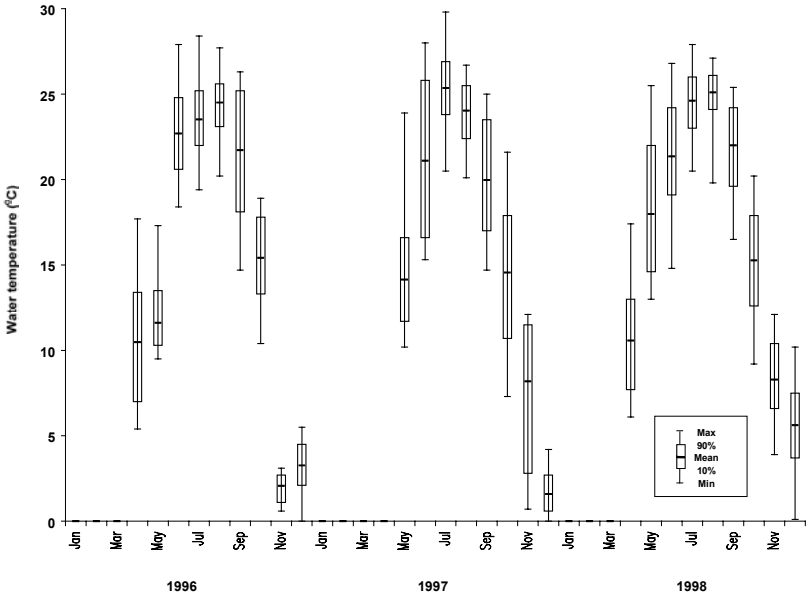


Figure 54. Water temperature statistics for Tivoli South Bay, 1996-1998.

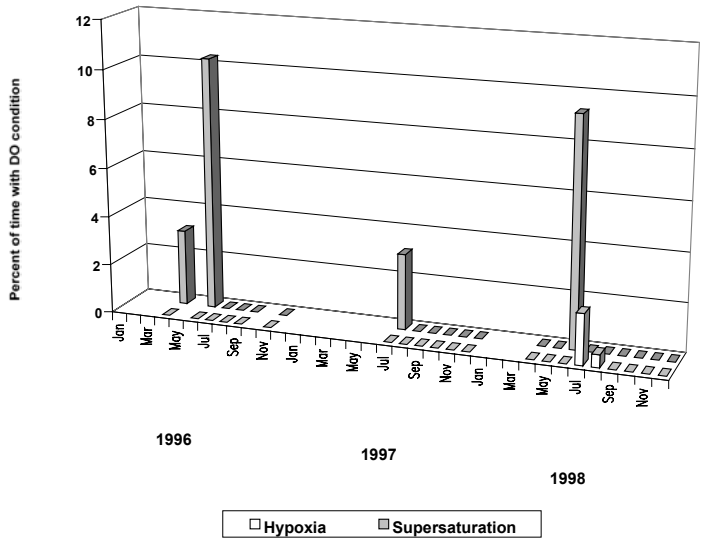


Figure 55. Dissolved oxygen extremes at Tivoli South Bay, 1996-1998.

Photosynthesis/Respiration

Three quarters (76%) of the data used to calculate the metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor) and were used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 18). Instrument drift during the duration of the deployments was not a significant problem at this site. Total respiration exceeded gross production at Tivoli South Bay; thus, the net ecosystem metabolism and P/R ratio indicated that this is a heterotrophic site (Figure 56). Temperature was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Gross production and respiration increased as temperature increased, while net ecosystem metabolism became more heterotrophic as temperature increased. In this freshwater system, salinity was always zero ppt. Metabolic rates were extremely variable during the growing season of Eurasian water chestnut that covers Tivoli South Bay between June and September.

Table 18. Summary of metabolism data and statistics at Tivoli South Bay, 1996-1998.

Tivoli South	mean	s.e.
Water depth (m)	1.5	
Net production $gO_2/m3/d$	0.40	0.06
Gross production $gO_2/m3/d$	2.41	0.13
Total respiration $gO_2/m3/d$	3.58	0.16
Net ecosystem metabolism g $O_2/m3/d$	-1.18	0.07
Net ecosystem metabolism g C/m2/y	-118	
P/R	0.67	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	76 %	
Paired t-test on gross production and total respiration	$p < 0.001$	
Correlation coefficient	Temperature	Salinity
Gross production	0.50	ns
Total respiration	0.61	ns
Net ecosystem metabolism	-0.45	ns

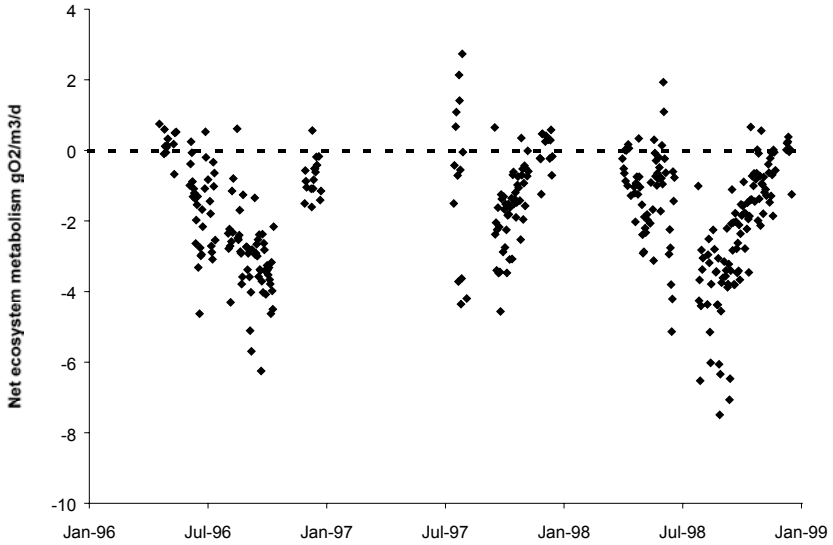


Figure 56. Net metabolism at Tivoli South Bay, 1996-1998.